Institution: University of Leicester

Unit of Assessment: 8 Chemistry

Title of case study: Supporting regional businesses to use satellite derived data

1. Summary of the impact

University of Leicester research has developed, with funding from the European Regional Development Fund, a business support offer, Global Monitoring for Environment and Security (GMES) Space Technology Exchange Partnership (G-STEP) - which has led to a number of impacts:
Economic impacts via direct support of 40 East Midlands companies, including the creation of 3 new businesses, with a £950K GVA (Gross Value Added) to the companies and £2.9M in investment in the East Midlands. It has led to the employment of 20 Leicester graduates.
Policy impacts via the Local Economic Partnership which has identified space as one of three emerging sectors for focussed development. Nationally, the emerging Satellite Applications Catapult has reviewed the G-Step delivery model to inform its own operation. Internationally, G-STEP led the NEREUS (Network of Regions in Europe Using Space) Earth Observation/GMES working group and produced the "The Growing Use of Space Across Europe", launched at the European Parliament in 2012.
Environmental benefits via the development of products which are having a positive impact on the environment including satellite enabled traffic management tools and high value crop management.

2. Underpinning research

Since 1992, the research that underpins G-STEP has been developed by the Earth Observation Science (EOS) group at the University of Leicester. G-STEP is based in chemistry and its director is from Chemistry (**Monks)**. EOS is a multi-disciplinary group, initially founded through a joint University/national (NERC) initiative that has matured into internationally leading research making substantial contributions to research science, government policy, industrial activity and education of the public. The group undertakes fundamental and leading research in applied physics, chemistry and geography as well as developing technological innovation through the design and production of satellite instruments for observing the Earth mainly with funding from NERC, ESA and industry. The group exploits EO data for climate change studies, air quality, environmental monitoring and mapping applications with everyday impact [1]. The quality of the science is evidenced by leading positions on international science teams, data exploitation and EC services. The major EOS research themes are a) Air Quality (led by **Monks** (Chemistry, 1996- present) with **Leigh** (Chemistry, 2010- present), b) Climate Change (led by Remedios (Physics and Astronomy, 2000 - present) c) Land-surface change (led by Baltzer (Geography, 2006 – present) and d) Space Technology (led by **Monks** (Chemistry).

G-STEP draws from a portfolio of research translating a wide knowledge base into industrial impact, within which a key driver is responding to company needs and problems, thus making it demand rather than supply led. Research that has been translated in G-STEP includes work by **Monks** and **Leigh** who have developed new technology and measurements from space [2, 3], ground [4] and aircraft for validating emissions of criteria air pollutants, in particular nitrogen dioxide. Air quality work has focussed on quantifying oxidative capacity change in urban and rural environments over the last decade [5]. Results have shown that the effectiveness of air quality reductions in ozone precursors is being masked by a combination of meteorological variability and change in background conditions [5]. The work on Air Quality detection and attribution [2, 4] is the basis for the intelligent traffic management system described latterly. The greenhouse-gas (GHG) from space work [3] has quantified regional GHG budgets, and has latterly been translated into the policy arena, as has the ozone work [5].

3. References to the research

1. **Monks PS**, Beirle S (2011) Applications of Satellite Observations of Tropospheric Composition. In: Burrows JP, Platt U, Borrell P (eds) Remote Sensing of Tropospheric Composition from Space. Physics of Earth and Space Environments. Springer-Verlag Berlin, Berlin, pp 365-449. doi:10.1007/978-3-642-14791-3_8. The development and delivery of this book chapter was supported by the EU FPVI ACCENT program £216,000 to University of Leicester.
2. Whyte C, **Leigh RJ**, Lobb D, Williams T, Remedios JJ, Cutter M, **Monks PS** (2009) Assessment of the performance of a compact concentric spectrometer system for Atmospheric Differential Optical Absorption Spectroscopy. Atmos Meas Tech 2:789-800. Work supported by Centre for Earth Observation Instrumentation grant from NERC and DIUS (now BIS) for £120,000.
3. Palmer PI, Barkley MP, **Monks PS** (2008) Interpreting the variability of space-borne CO_2 column-averaged volume mixing ratios over North America using a chemistry transport model. Atmos Chem Phys 8 (19):5855-5868. Work originally supported by NERC Centre of Excellence grant from CASIX (Centre for Air-Sea exchange) ca. £70,000 Cited 8 times (ISI 17th Sept 2013).
4. Kramer LJ, **Leigh RJ**, Remedios JJ, **Monks PS** (2008) Comparison of OMI and ground-based in situ and MAX-DOAS measurements of tropospheric nitrogen dioxide in an urban area. J Geophys Res-Atmos 113 (D16):-. doi:Artn D16s39. Work supported by NERC funding. Cited 20 times (ISI 17th Sept 2013).
5. Wilson RC, Fleming ZL, **Monks PS**, Clain G, Henne S, Konovalov IB, Szopa S, Menut L, Have primary emission reduction measures reduced ozone across Europe? An analysis of European rural background ozone trends 1996–2005 *Atmos. Chem. Phys.,* 12, 437–454, 2012. Supported by the EU FPV GeoMON program £130,000 to the University of Leicester. Cited 12 times (ISI, 17th Sept 2013).

4. Details of the impact

The University of Leicester aligned its research strengths in atmospheric chemistry and earth observation science with emerging economic development objectives in Europe and the East Midlands Region. These objectives were advanced by promoting the use of satellite data by businesses. The partnership of the University of Leicester, European Regional Development Fund (ERDF) and East Midlands Development Agency jointly funded a business support offer, Global Monitoring for Environment and Security Space Technology Exchange Partnership (G-STEP).

G-STEP is the UK's only academic-business partnership specifically set-up to exploit GMES & Copernicus space data and services. It provides a shop front to exploit the research of the university in this field. It has been at the forefront of heralding the emerging market opportunity in the exploitation of satellite-derive data to create new products and services leading to business growth and value added.

The delivery of G-Step has been managed by University of Leicester under the direction of Professor Paul Monks. The project has led to a number of impacts.

A) Economic Impact on the Region's Small & Medium Enterprises (SMEs)
The economic impacts have largely been in the growth of the awareness of the opportunity provided by satellite data . The project has informed the work of 500 hundred businesses and 20 Local Authorities in the UK and internationally and has directly supported 40 East Midlands companies through its targeted interventions. The development of new products/services and the training of businesses in the use of EO and GIS products have led to a net GVA increase within those 40 companies of £950K over 4 years. It has further generated £2.9M in investment in the East Midlands regional economy (**A**). Twenty University of Leicester graduates have been employed in East Midlands companies where their skills and knowledge in this area are put to good use. G-STEP has also assisted with the creation of three new businesses, all SMEs working

in the area of remote sensing.

B) Policy Impact
The success of G-STEP has been significant in the identification of upstream and downstream Space technologies as a targeted growth sector by the Leicester & Leicestershire Local Economic Partnership within its strategic economic growth plan for the region (**F**).

On a national level, the Government has invested in 7 Catapult organisations which aim to exploit areas of technology in which Britain has a potential world leading position. The emerging Satellite Applications Catapult has reviewed the G-STEP model of SME engagement and will use the model to shape its own SME engagement process.

In Transport Policy, G-STEP has developed two major projects which are directly influencing local and regional policy. ITRAQ was an ESA-funded collaborative programme (2011-12) which had the former Transport Research Laboratory (TRL) as its commercial prime and three local authorities involved in the initial system implementation (**C**). ITRAQ employed novel space and ICT solutions to develop active traffic management systems that balance the need to reduce congestion with the requirement to improve air quality. As air quality becomes an increasingly important issue for local authorities worldwide, the product developed as a result of research by Monks/Leigh (UoL) in partnership with De Montfort University and marketed by TRL, is expected to have a global market of £ several millions.

THE-ISSUE (2011-14, **D**) is a project for co-ordination and exploitation of Research, Technology, Development and Innovation (RTDI) in areas related to Traffic, Health and the Environment. The project is led from G-STEP with French, Italian and Polish partners, who together support over 100 RTD projects (42 in the East Midlands) that use some degree of ICT, satellite-derived spatial data infrastructure (SDI) or location and timing services from satellites for transport applications in: intelligent transport systems; traffic management; intermodal solutions for public transport and citizens; freight logistics; and air quality management.

At an international level, G-STEP has been leading the NEREUS (Network of Regions in Europe Using Space) EO/GMES working group and produced the "The Growing Use of Space Across Europe" document that was launched at the European parliament in October 2012 [**B**].

C) Environmental Products
G-STEP has worked with Havana Energy (a British power-generating company, **E**) and the Cuban Government to develop an 'energy map' of several regions in Cuba. The work shows the amount of biomass available for use as a renewable energy source. Exploiting satellite-derived data to estimate the amount of biomass available allows Cuba to plan for the exploitation of its own natural resources to meet energy needs. An ancillary output of the project is to identify and manage unwanted non-productive invasive species of plant which will be replaced by sugar crops. The project is funded entirely by Havana Energy. The Cuban Government is delivering policy change in agriculture using this product.

The UK potato and sugar beet industries are worth over £1bn per year. HIVACROM (High Value Crop Monitoring, 2012-13) is a TSB-funded partnership between G-STEP (Remedios/Monks; **G**) and CGI IT UK Ltd which developed a proof of concept for a near-real-time, dynamic integrated crop monitoring service derived from Earth Observation data which is now commercially available.

5. Sources to corroborate the impact

A. **Third Party Audits** - Verification of G-STEP impacts are available through ERDF A13/A16 audits and final audited report for G-STEP1. These provide third party assurance and measure of economic outputs and results.

B. **Output from NEREUS (Networks of Regions of Europe Using Space) RTD Audit across Europe -** G-STEP - The Growing Uses of Space across Europe http://esamultimedia.esa.int/multimedia/publications/NEREUS/ Major European synthesis

of activity led by G-STEP that also details G-STEPs reach and impact.

C. **Outputs on Intelligent Traffic Management** - I-Traq, Traffic Technology International August/September 2012, p18. (www.TrafficTechnologyToday.com). Full details and final reports from ESA IAP website http://iap.esa.int/projects/transport/itraq

D. http://www.theissue.eu/

E. **Testimonials** - Testimonials available from customers:
1. Operations Director, Bluesky International
2. Director, Rockkitchenharris
3. Agricultural Advisor, Havana Energy
4. Environmental Consultant

F. **Regional Economic Plan -** LLEP (Leicester and Leicestershire Economic Partnership) Economic Growth Plan 2012-2020 http://www.llep.org.uk/index/downloads/filename/img_1343645215_1755.pdf/catid/22/filetitle/economic-growth-plan.pdf

G. **Grant Support to G-STEP -** Prof. Paul Monks, Prof. John Remedios & Prof. Heiko Balzter, G-STEP (GMES Space Technology Exchange Programme), East Midlands Development Agency & ERDF, Apr 2009- Mar 2013, £ 1,860,00+£260,515. Follow on program G-STEP2 ERDF - £ 679,158